The main lines of the work

- Calibration of QSPA-Be which include the measurements of plasma velocity, pressure, and heat load depending on operating parameters;
- Optimization of QSPA-Be power supply system to obtain power pulse form relevant to different transient plasma events of ITER;
- Experimental study of plasma stream energy transformation to radiation for mitigated disruption simulation;
- Experimental study of beryllium erosion under ITER ELM-like plasma heat loads up to 1.6 MJ/m² and pulse duration 0.5 ms.

Calibration and optimization of QSPA-Be

Plasma pressure and plasma flow velocity

To measure the plasma pressure the pressure probe with sensitive element from CTS-19 ceramic was applied. The typical curve of pressure probe for two different gap distance is shown in the figure. As a result of the investigation the parameters of the power supply system was determined to generate triangular discharge power pulse. The front of pulses may be varied in the range of 0.2-0.5 ms.

Optimization of QSPA-Be power supply system

Using the standard power supply system QSPA-Be facility generates plasma flows with duration 0.5 ms and the triangular discharge power pulse.

As a result of the investigation the parameters of the power supply system was determined to generate triangular discharge power pulse. The front of pulses may be varied in the range of 0.2-0.5 ms.

Radiation source for the mitigated disruption simulation

Experimental study of plasma flow energy transformation to radiation with the view of generating the radiation corresponding the ITER mitigated disruptions was carried out.

The experiments

- Working gas: the mixture of hydrogen and argon graph plate (MPG-8)
- Target: graphite plate (MPG-8)
- Working gas: the mixture of argon and hydrogen (the working gas is 1% Ar+99% H₂)
- Target: graphite plate (MPG-8)
- Target: graphite plate (MPG-8)

Results of the experiments

The maximum value of the radiation energy was obtained using the mixture 1% Ar+99% H₂ as the working gas. The maximum value of the radiation energy corresponds to the distance from the target 8,5cm and gun voltage 4kV is equal 90 J/cm².

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As a result of the beryllium target exposure by hydrogen plasma flow the melted region is observed on the samples surface. The formation melted region is caused by exceeding the heat load over the melting threshold. Since the sizes of melted region and absorbed energy density distribution are known the melting threshold may be determined.

Experimental determined melting threshold for both type of beryllium samples is equal 0.5 MJ/m².

Beryllium erosion

The measurements of the samples mass were implemented after 10-40 pulses. On the basis of the measurements the average value of specific mass loss was calculated.

- The maximum mass loss is observed at first pulses and lies at level 3,5 g/m²/pulse (erosion rate 1.8 µm/pulse).
- The value of mass loss is decreased with increasing of number of pulses and already after 50 pulses lies at level 0.5 g/m²/pulse (erosion rate 0.3 µm/pulse).
- The beryllium mass loss mainly due to the mass loss of the melt layer on the surface of samples.

Programme of beryllium researches

- Beryllium erosion under exposure to plasma flow
- Beryllium erosion under exposure to radiation
- Beryllium dust and films
- Mixed materials (Be/W/C)

First beryllium experiments on QSPA-Be

The different type of beryllium (TGP56-FS and S-65C) were exposed by hydrogen plasma flow in the heat loads range of 0.3-1 MJ/m², 0.5 ms pulse duration and inclined plasma action.